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*Full Length Research Paper*

## **Month wise catch per unit effort of sardine species *Sardinella fimbriata* and *Dussumieria acuta* in Artisanal and Industrial fishing sector.**

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The investigation was carried out on the sardine fish species availability which captured in artisanal and industrial fishing sector during January, 2012 to December, 2012 from the onshore and off shore water areas of our marine water and total production of sardines was 7352.99MT, among this 1747.22 MT was exploited by the coastal mechanize boats in inshore areas which contributed 23.76% by weight of total sardine fish production and 5605.77 MT harvested from different industrial fish trawlers and contributed 76.24% to the total sardine landing in deep-sea fisheries and 17.51% contributed to the total fish production by commercial fish trawlers at the same study period. Still now 4 sardine species are recorded in the Bangladesh region of the Bay of Bengal. Among them, two sardine species are abundantly available and they are, Fringe-scale sardine- *Sardinella fimbriata* is locally call as 'sagar chapila' and its total landing volume was 5495.79MT (74.74%) of the total landed sardines in artisanal and industrial fishing; of which contributed 31.79% (1747.22MT) in artisanal and 68.21% (3748.57MT) from industrial sector to the total production volumes of *S. fimbriata*. And the rain bow sardine-*Dussumieria acuta* call as 'Colombo machh', this contributed 25.26% (1857.20MT) only in industrial fishing sector in our sampling period. Generally, in artisanal fishing the peak capture season of sardine species, *S. fimbriata* is in the rainy season and in industrial fishing major harvesting season of *S. fimbriata* are the end of late autumn to first of winter in night times. *D. acuta* harvest only in industrial fishing and peak production season is in the winter season and highest catch observed at night in the full moon and new moon period and a few days after and before full moon and new moon. *S. fimbriata* are exploits within 10-20 meters depth and abundantly available in the southern part of the South patches and South of south patches and capture 10-50 m depth in north-west to north-east of Middle ground (Kohinoor point) and *D. acuta* are harvest within 40-60 m. depth and available in the north-west to north-east of Middle ground areas (Kohinoor point) and south-west to south-east of Middle ground (Kohinoor point) in the Bangladesh region of the Bay of Bengal. Catch per unit effort (CPUE) of *S. fimbriata* was 171.28 kg observed in artisanal fishing. Average CPUE was 172.50 kg in the selected fish landing center of Shahparir dwep followed by 198.77 kg, 257.77 kg, 189.88 kg, 115.66 kg and 93.10 kg were at Teknaf sadar, Shamlapur, Moheskhali, BFDC fish harbour, Cox's Bazar and Fishery ghat fish landing center in Chittagong district respectively. In industrial fishing average CPUE was 772.68 kg recorded at the same sampling period.

**Keywords:** Total landing, Middle ground, South Patches, South of south Patches, Kohinoor point, Artisanal and Industrial fishing.

## INTRODUCTION

In industrial fishing sector 67 white fish trawlers, 11 modern white fish trawlers, 10 demersal trawlers, 10 mid water trawlers, 39 trial tip trawlers (137 fish trawlers) are harvesting from the off shore areas and 22000 numbers of mechanized boats are exploiting in onshore areas at artisanal fishing also (DOF, 2011-2012). In our marine territory total 475 fish species and 36 shrimp species are available. Among the pelagic resource the clupeids comprise a group. Among the clupeids, sardine is one of them which captured by mechanized boats and all fish trawlers.

During 2011-2012 total 20187.0 MT of sardines was captured from the Bay of Bengal of Bangladesh region. In artisanal fishing total sardine fish production amounts was 9082.0 MT (44.99%) and in industrial fishing was 11105.0 MT (55.01%) which contributed 1.57% and 1.92% to the total marine fish catch in artisanal and industrial fishing respectively (DoF, 2011-12).

Sardines; are named after the Mediterranean island of "Sardinia", around which they were once abundant (Internet, 2012). 61 species of sardines are recorded in the world; still now 04 (four) species of sardine have been reported from the Bay of Bengal of Bangladesh region. Generally two sardine species *Sardinella fimbriata* and *Dussumieria acuta* are abundantly available in our marine water areas which are now commercially important. Maximum catch of sardines (*S. fimbriata* and *D. acuta*) was observed at night, in full moon, new moon period and a few days before & after full moon, new moon period.

The most important gear is Rog jal (30m.m mesh monofilament gill net) which is newly introduce in our country in on shore fishing for capture *S. fimbriata* .is being more abundant and exploiting commercially as target species and as by catch in Beach seines, Bata jal (20 m.m mesh gill net) incidental catch of set bag nets in artisanal fisheries and also as by catch of fish trawl in industrial fishing. *D. acuta* are harvesting as by catch only in all fish trawl. Locally *S. fimbriata* is called as 'Sagar Chapila or Takia or Phansha' and *D. acuta* is as 'Colombo machh or Khaira or Khoira'. In artisanal fishing *S. fimbriata* are exploits year round but three main exploiting periods are, June to August, October to November and March to April, but major peak capture months are June to August in artisanal fishing and in industrial fishing sector two peak capture month

observed in *S. fimbriata* are the end November to December and late February to first April, but main peak capture is the November to December month. And for *D. acuta* major fishing take place December to April but, main peak capture period are the month of January to February which harvest by different fish trawl.

Sardines are generally sort lived (one to two years); several types of small, silver in color and oily fish, it's shorter in length than 6 inches (15 cm), their maximum length 20.0 cm. Sardines are rich in vitamins and minerals. Sardines are also a natural source of marine omega-3 fatty acids, which reduce the occurrence of cardiovascular disease (Internet, 2012).

Sardines are commercially fished for a variety of uses; the chief use of sardines is for human consumption, but fish meal is used as animal feed, while sardine oil has many uses, including the manufacture of paint, varnish and linoleum.

The world annual catch of forage fish (e.g. Sardine) is recent (2012) year has been around 22 million tones, or one quarter of the world's total catch. World capture production of marine fish was 66 million tons (Internet, 2012).

In our study period total sardines fish landing volumes was recorded 7352.99 MT; on which 76.24% contributed by artisanal fishing and rest 23.76% came from trawl fishing.

There is no specific work on the sardine fishery in Bangladesh. So, this study was initiated to find the availability of sardine species to estimate total landing of sardines, percentage composition and their seasonal abundance in the Bay of Bengal of Bangladesh region in 2012 period.

## MATERIALS AND METHODS

### Sampling station

The six main landing centers are Shah parir dweep, Teknaf sadar, Shamlapur, Moheskhali, BFDC fish harbour, Cox's Bazar and Fishery ghat in Chittagong district have been selected as sampling station for collect data collection in artisanal fishing and all kinds of fish trawl in industrial fishing from the Bay of Bengal of Bangladesh region.

### Description of craft and gear

More than 700-800 numbers (Shah parir dweep: 180-200 nos., Teknaf sadar: 120-130 nos., Shamlapur: 180-200

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nos., BFDC fish harbour, Cox's Bazar: 130-150 nos, Mosheshkali: 40-60nos. and Fishery ghat: 50-60 nos. of boats) of mechanized artisanal boats contribute for capture the sardine fishery. These artisanal fishing boats are typically 8-9 m. long and 2.13-2.50 m width and having engine horse power ranges from 20-22 HP. in Cox's Bazar district and in Chittagong district the artisanal boats are 10-10.5 m. long and 3.0-3.25 m. width and carried 65-75 HP. 137 numbers of different kinds of commercial fishing trawlers harvest the sardines; these trawlers' engine horse powers are 450-1900 HP marine diesel engine and head rope length of the trawl are 50-110m.

Rog jal or 30 numbers net, is a monofilament small mesh drift gill net (SMD), which 30 mm mesh size, width 6-7m and length 1600-1700 m and Bata jal which are 20 mm mesh, 2-3 m width and 100-200 m length; thread number 4.

### Data collection and analysis

Data were collected from January, 2012 to December, 2012 period. Two species of sardines (*Sardinella fimbriata* and *Dussumieria acuta*) are exploited commercially mainly at night in the new moon, full moon periods, a few days before and after the new moon and full moon period; totally 15 to 16 active fishing days in a moon month. Sampling was carried out around the year by the Marine Fisheries Survey Management Unit, Chittagong. In commercial fishing data were collected from the trawlers fishing log sheet and tally counter sheet which supplied by the Marine Fisheries Office, Chittagong. The abundance of sardines is located by using GPS (Global Positioning System) to visit in fishing trawlers. Collected data were processed and analyzed using Microsoft Excel.

## RESULT

During January, 2012 to December, 2012 total 7352.99 MT of sardines was landed, among these 1747.22 MT from the artisanal fishing and 5605.77 MT from the industrial fishing sector and the two sardine species were identified as a contributor, they are *Sardinella fimbriata* and *Dussumieria. acuta* and contributed 5495.79MT (74.74%) and 1857.20MT (25.26%) respectively.

### Artisanal fishing

In artisanal fishing only one species of sardine i.e. *S. fimbriata* was recorded which abundantly available and exploited in the on shore areas. During January, 2012 to

December, 2012 total landing amounts of sardines was 1747.22 MT from the selected six landing centers. Sardines have been exploited only from March to December. There was no fishing observed in the month of January and the February in artisanal fisheries during the study period (Table, 1).

### Landing center wise total landing

In Shaparir dweep fish landing center, total 393.09 MT of sardines was landed during the study period. The highest landing was found 96.30 MT in the month of July, 2012 and lowest was 3.44 MT in November, 2012. At Teknaf sadar fish landing center, total 297.04 MT of sardines was recorded. The maximum and minimum landings were 72.50 MT and 0.26 MT in the month of July, 2012 and November, 2012 respectively. In Shamlapur fish landing center, total production amounts of sardine was 587.72 MT; highest production was 150.55MT in July, 2012 and lowest was 0.16MT in the month of December, 2012. At BFDC, Cox's Bazar fish harbor, total 337.00 MT of landed sardine was recorded. The maximum and minimum catches were 120.16 MT and 0.54MT in the month of July, 2012 and November, 2012 respectively. In Moheshkali fish landing center, 76.52 MT of sardine was caught and highest catch was 22.0 MT in the month of July, 2012 and minimum was 0.23 MT in December, 2012. In the Fishery ghat, Chittagong fish landing center, total 55.86 MT of sardine was exploited, maximum and lowest production were 38.50 Mt and 1.15 Mt in Jul, 2012 and November, 2012 respectively (Table, 1 and Figure, 1).

### Month wise total landing

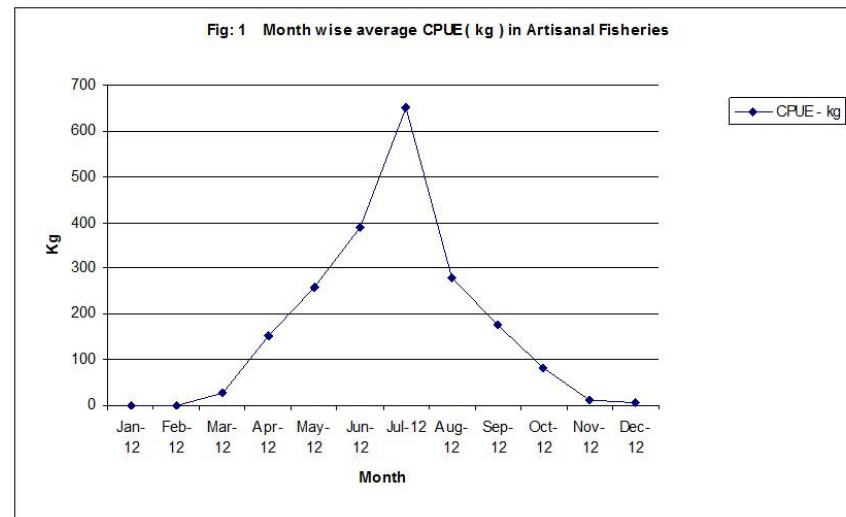
In month wise production, total 25.90 MT of sardine species was landed in the month of March, 2012 followed by April 2012, May, 2012, June, 2012, July, 2012, August, 2012, September, 2012, October, 2012, November, 2012, and December, 2012 were 152.00 MT, 225.00 MT, 361.00 MT, 500.01 MT, 238.57 MT, 174.51 MT, 56.04 MT, 8.17 MT and 6.02 MT respectively (Table, 1 and Figure, 2).

### Catch per unit effort (CPUE)

750 numbers of mechanized boats have been engaged in on shore fishery for capture the *S. fimbriata* in artisanal fishing sector. Total 1747.22MT of sardines was exploited within 1092 fishing days in artisanal fishing and average catch per day in each boat (CPUE) was 171.28 kg. In shahparir dweep fish landing center, CPUE was 23.68kg. in the month of March, 2012

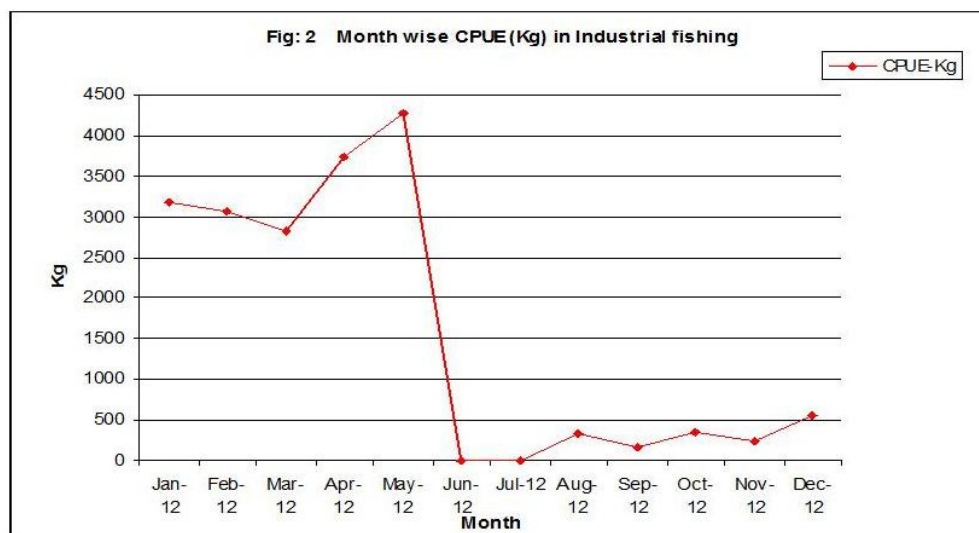
**Table: 1** Month wise catch per unit effort (CPUE) of sardine species in artisanal fishing

Name of the Ghat	Total boat landed	Total sardine landing (MT)	Jan,12 CPUE (Kg)	Feb,12 CPU (EKg)	Mar, 12 CPUE (Kg)	Apr,12 CPUE (Kg)	May, 12 CPUE (Kg)	Jun,12 CPUE (Kg)	Jul, 12 CPUE (Kg)	Aug, 12 CPUE (Kg)	Sept, 12 CPUE (Kg)	Oct, 12 CPUE (Kg)	Nov, 12 CPUE (Kg)	Dec, 12 CPUE (Kg)	active fishing days
Shahparir Dwep	190	393.09	-	-	23.68	168.42	252.63	463.16	507.89	360.53	222.11	53.42	18.11	-	15
Teknaf Sadar	125	297.04	-	-	26.08	160.00	224.00	528.00	580.00	308.80	401.84	145.52	2.08	-	15
Shamlapur	190	587.72	-	-	88.42	294.74	463.16	631.58	792.37	485.79	290.79	37.68	7.89	0.84	15
BFDC Cox's Bazar	140	337.00	-	-	-	271.43	321.43	564.29	858.29	127.14	14.29	77.64	3.86	40.21	16
Moheskhali	55	76.52	-	-	24.56	109.69	290.91	145.45	400.00	269.09	39.27	85.45	23.27	0.42	15
Fishery ghat	50	55.86	-	-	-	-	-	-	770.00	131.40	93.40	99.40	23.00	-	15
<b>Total:</b>	<b>750</b>	<b>1747.22</b>	-	-	-	-	-	-	-	-	-	-	-	-	<b>91</b>



**Table: 2 Month wise catch per unit effort (CPUE) of Sardine species in Industrial fisheries**

Name of the month	No of Trawler	Fishing days	Total landed sardine (MT)	Catch per unit effort (CPUE- kg)	Total landed fish (MT)
January, 12	10	200	635.69	3178.45	1351.10
February, 12	10	188	576.86	3068.40	1266.52
March, 12	10	245	692.03	2824.61	1353.06
April, 12	10	162	604.62	3732.22	1281.08
May, 12	10	88	376.74	4281.14	841.13
June, 12	-	-	-	-	-
July, 12	-	-	-	-	-
August, 12	40	323	109.71	339.66	1817.61
September, 12	106	964	433.24	161.84	4484.75
October, 12	108	952	334.80	351.68	3246.83
November, 12	121	1442	355.04	246.21	5146.75
December, 12	137	2691	1487.04	552.60	11224.50
Total		7255	5605.77		32013.33

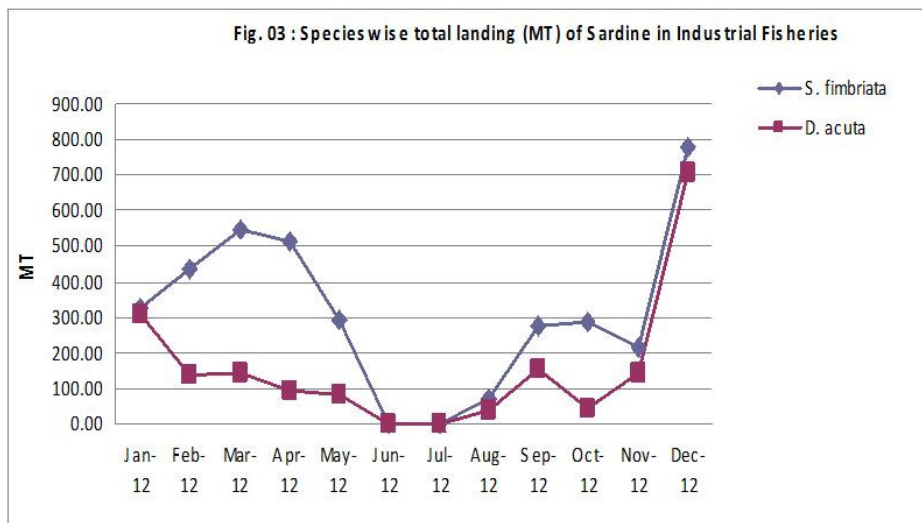


followed by 168.42 kg, 252.63 kg, 463.16 kg, 507.89 kg, 360.53 kg, 222.11 kg, 53.42 kg and 18.11 kg were in the month of April 2012, May, 2012, June, 2012, July, 2012, August, 2012, September, 2012, October, 2012 and November, 2012, respectively. Average CPUE was 172.52 kg (Table, 1 and Figure, 1).

In Teknaf sadar average CPUE was found 172.50 kg. In the month of March, 2012 CPUE was 26.08 kg followed by April 2012, May, 2012, June, 2012, July, 2012, August, 2012, September, 2012, October, 2012 and November, 2012 were 160.00 kg, 224.00 kg, 528.00 kg, 580.00 kg, 308.80 kg, 401.84 kg, 145.52 kg and 2.08 kg respectively (Table, 1 and Figure, 1).

At shamlapur fish landing centers CPUE was 88.42 kg recorded in the month of March, 2012 followed by 294.74 kg, 463.16 kg, 631.58 kg, 792.37 kg, 485.79 kg, 290.79 kg, 37.68 kg, 7.89 kg and 0.84 kg were in the month of April 2012, May, 2012, June, 2012, July, 2012, August, 2012, September, 2012, October, 2012, November, 2012 and December, 2012 respectively and average CPUE was 257.77 kg (Table, 1 and Figure, 1).

In BFDC fish harbour average CPUE was 189.88 kg. At April, 2012 CPUE was found 271.43 kg followed by in the month of May, 2012, June, 2012, July, 2012, August, 2012, September, 2012, October, 2012, November, 2012 and December, 2012 were 321.43 kg, 564.29 kg,



858.29 kg, 127.14 kg, 14.29 kg, 77.64 kg, 3.86 kg and 40.21 kg respectively (Table, 1 and Figure, 1).

At Moheskhali fish landing center CPUE was 24.36 kg recorded in the month of March, 2012 followed by 109.69 kg, 290.91 kg, 145.45 kg, 400.00 kg, 269.09 kg, 39.27 kg, 85.45 kg, 23.27 kg and 0.42 kg were in April 2012, May, 2012, June, 2012, July, 2012, August, 2012, September, 2012, October, 2012, November, 2012 and December, 2012 respectively Average CPUE was 115.66 kg August, 2012, September, 2012, October, 2012, November, 2012

In Fishery ghat fish landing center average CPUE was found 93.10 kg. In the month of July, 2012 CPUE was 770.00 kg followed by August, 2012, September, 2012, October, 2012 and November, 2012 were 131.40 kg, 93.40 kg, 99.40 kg and 23.00 kg respectively (Table, 1 and Figure, 1).

### Trawl fishing

Total 137 numbers of fishing trawlers harvested 5605.77 MT of sardines in offshore areas in industrial fishing. Two species of sardine i.e. *S. fimbriata* which contributed 3748.57MT, 66.87 % and *D. acuta* the rest 1857.20MT, 33.13% during January, 2012 to December, 2012. These two species were captured from January, 2012 to May, 2012 and August, 2012 to December, 2012 period. There was no fishing in the June and the July; this was happened due to rough sea condition according to the collected information from the skipper of the trawlers (Table, 2, and Figure, 3).

### Month wise total landing

In the month wise catch total 635.69 MT of two sardine species were harvested in the month of January, 2012 followed by February, 2012, March, 2012 April 2012, May, 2012; August, 2012, September, 2012, October, 2012, November, 2012, and December, 2012 period were 576.86 MT, 692.03 MT, 604.62 MT, 376.74 MT, 109.71 MT, 433.24 MT, 334.80 MT, 335.04 MT and 1487.04MT respectively (Table, 2 and Figure, 3).

### Catch per unit effort (CPUE)

During our study period total 5605.77 MT of sardines landed within the 7255 fishing days. Average catch per day in each fish trawler (CPUE) was 772.68 kg. In the month of January, 2012 CPUE was 3178.45 kg followed by February, 2012, March, 2012 April 2012, May, 2012, August, 2012, September, 2012, October, 2012, November, 2012, and December, 2012 were 3068.40 kg, 2824.61 kg, 3732.22 kg, 4281.14 kg, 339.66 kg, 161.84 kg, 351.68 kg, 246.21 kg and 552.60 kg respectively (Table,2).

### Length and weight of landed sardine species

Length and weight also measured in the sardine species of *S. fimbriata* and *D. acuta* in centimeters and grams from our marine territory. The length range of *S. fimbriata* was recorded between 12.0-17.0 cm and

weight range was 30.0-55.0 grams, the average landed size was 15.22 cm and average weight 40.50 gm; In *D. acuta* length ranges were recorded between 14.0-19.0 cm and weight range 40.0-80.0 grams, average size and weight were recorded 19.36 cm and 57.40 gm respectively.

## DISCUSSION AND CONCLUSION

They are exploiting from depth range 10-60 meters, but some times found in 90 m depth. *S. fimbriata* has exploits 10-20 m. depths in artisanal sector and some times capture from 10-50 m. depth in industrial fish trawl also. *D. acuta* generally harvest 40-60 m. depth zone, suddenly captured from 90 m. depth in trawl fishing.

Sardines are generally short lived and their stocks fluctuate markedly over the years. Oil sardines attain sexual maturity at the age of one year at a length of 150 mm ((Pillai, 2000).The fish are caught mainly at night; when they approach the surface to feed on plankton. They follow vertical migrations of the zoo-plankton; they feed on to the bottom during daytime and to the surface at night time (Internet, 2012).

During cruises 9 and 10 in Feb, 1985, 93 hauls were undertaken at night. These data have been compared with those of day cruises 6 and 8 in December 1984 and January 1985 where 87 days hauls were undertaken during day time. In sardines comparison of day/ night ratio was 2: 19 (Lamboeuf, 1987).

Maximum sardines are exploited at new moon and full moon periods and a few days before & after full moon, new moon from the district of Cox's Bazar coast in artisanal fishing and in the Middle ground areas of Dublar char coast by trawl fishing. *Sardinella fimbriata* are exploiting commercially and maximum are caught mainly at night times and maximum *Dussumieria acuta* are capture in night from the Bay of Bengal of Bangladesh region which is related to the mentionable discussion of Internet, 2012 and Lamboeuf,1987 report.

Sardines are generally harvested in an environmentally friendly manner an area a renewable source of seafood. Sardines are quick-growing and spawn several times a year, making them a resilient fishery. In addition, they are usually caught with purse seines or mid water trawls, which are less environmentally disruptive than other forms of fishing (Voss, 2009).

According to the Domanevsky (1976) there are two spawning times for the sardine. The major spawning takes place in winter and a weaker peak in spawning occur in spring. The abundance of the sardine in the North Sea suddenly increased after 1995. Since 2002, the sardine has been spawning regularly in the German Bight and all its life stages can be found in the area (Voss, 2009).

Two species of sardines namely, *Sardinella fimbriata* (VAL) and *Sardinella gibbosa* (BLKR) contribute to the sardine fishery at Lawson's Bay, Waltair, extending over a period of 9-10 months (October to June or July) and the fishery is mainly supported by the juveniles of the two species, *S. fimbriata* being more abundant ( Dharmamba, 1961). Small pelagic fish comprise important ecological links between plankton production and higher, piscivorous tropic level (Bakun, 2006); these fish are of substantial economic importance. Their management is, however, challenged by a highly variable recruitment success and hence large stock fluctuations.

Beare (2004) showed that the abundance of sardines in the North Sea increased suddenly after 1995. They often stay together in schools and may migrate large distance between spawning grounds and feeding grounds. They are found particularly in upwelling regains around the northeast Atlantic, off the coast of Japan and off the west coasts of Africa and the Americas.

Distribution of sardines by depth strata is that it occurs abundantly in 10-80 m. depth zone and mostly in 10-50 m. Lamboeuf, (1987) Fishery Biologist (R.V. Anusandhani) trawling survey results, September, 1984-June, 1986 found 43.7% sardine in 10-20 m. depth zone and 45.5% in 20-50 m. depth zone in the Bay of Bengal.

According to the cruise report no-3, 1984 of R.V. Anushandhai, the percentage composition of the catch clupeids (Herring, Sardines and shads) was 3.06% in 10-20 m, 26.31% in 21-30 m, 2.96% in 31-50 m, 2.57% in 51-100 m, 35.15% in 101-200 m and average 6.27% in the total catch ( Khan, 1985).

The abundance of the sardines in the Bangladesh region of the Bay of Bengal suddenly increased during 2011, which is related to the Voss, 2009 report in the North Sea areas and the more abundant of sardine species *S. fimbriata* in the Bay of Bengal like as report on Dharmamba, 1961. Maximum sardines are exploits at night and their distribution in the 10-50 m. depth zone in the Bay of Bengal of Bangladesh region which are related to the report on Lamboeuf, 1987. They are found particularly in upwelling regains and migrate large distance between spawning grounds and feeding grounds which are same according to the Beare (2004) report.

Sardines are capture more or less all the month of the year from the inshore to offshore areas in the Bay of Bengal. The sardine species *S. fimbriata* are abundantly available in the southern part of the South patches to south of south patches grounds in onshore areas of 10-20 m depth zones and the west coast to east coast of Middle ground areas at the offshore areas in 40-50 m depth and maximum are exploiting night times in full moon and new moon period. The major peak times is June to August, fewer peaks in March to April and less in October to November.



Major another species *D. acuta* generally found within the 50-60 m. depth zone areas and they are available in the north-west to north-east of Middle ground areas and south-west to south-east of Middle ground areas. Maximum are harvested in the month of December to April. But, main peak during the month of January to February and capture at night in full moon and new moon periods in different industrial fish trawlers. In our study period it is observe that, the dominant catch of sardine species is *Sardinella fimbriata* which are capture both in artisanal and industrial fishing and another species *D. acuta* harvest only in industrial fishing sector.

In artisanal fishing sardine species, only *S. fimbriata* were exploiting from March, 2012 to December, 2012 period, but in January, 2012 to February, 2012 no sardine species was caught in the sardine fisheries. From March, 2012 to July, 2012 period total landing were gradually increased but from July, 2012 to December, 2012 period landing were gradually decrease and lastly in January, 2012 to February, 2012 the availability of sardines were totally absent; but in this time they were caught in different fish trawl in the deep sea areas, because at the same periods they migrate from the on shore to the off shore areas.

In artisanal fishing total contribution of sardines was 1747.22 MT, 23.76% and in industrial fishing contributed the rest 5605.77MT, 76.24%, to the total sardine fish production in our study period. In industrial fishing, total landing volume of sardines was 5605.77MT of which *S. fimbriata* contributed 11.71%, 3748.57MT and *D. acuta* was 5.80%, 1857.20MT of the total fish production (32013.33MT) from all fish trawlers at the same study period.

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